

# Characteristics of patients with acute coronary syndrome in the COVID-19 pandemic

Acute coronary syndrome characteristics in patients with COVID-19

Emine Altuntas, Kanber Ocal Karabay, Songül Usalp, Bayram Bağırta, Ali Bayraktar, Filiz Celebi, Behzat Özdemir, Sükrü Cetin  
Department of Cardiology, Sancaktepe Sehit Professor Ilhan Varank Education and Research Hospital, Istanbul, Turkey

## Abstract

**Aim:** Coronavirus disease 2019 (COVID-19) has caused thrombotic disease. In this study, we aimed to determine the demographic and clinical characteristics of acute coronary syndrome (ACS) patients infected with COVID-19 and to investigate whether they differ from patients with ACS without COVID-19 in terms of these characteristics.

**Material and Methods:** The study was designed as a single-center retrospective study. Thirty- three COVID-19 infected ACS patients (Group 1) and 100 ACS patients without COVID-19 infection (Group 2) were included in the study.

**Results:** The groups were compared in terms of coronary angiographic data. Twenty-eight (84.8%) patients in Group 1 and 74 (74%) patients in Group 2 were presented as non-ST elevation myocardial infarctus. Patients were compared in terms of baseline Thrombolysis in Myocardial Infarctus (TIMI) flow, thrombus stage, myocardial blush (end), using of thrombus aspiration catheter, stent thrombosis, and TIMI flow after percutaneous coronary intervention, and it was observed that there was no statistical difference between the groups ( $p > 0.05$ ).

**Discussion:** COVID-19 infection can cause plaque rupture, myocardial damage, coronary spasm and cytokine storm by triggering the coagulation and inflammation process. The fact is that we did not encounter an increased thrombus load in this study.

## Keywords

Thrombosis, Inflammation, Acute Coronary Syndrome, COVID-19

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Corresponding Author: Emine Altuntas, Sancaktepe Sehit Professor Ilhan Varank Education and Research Hospital, Namik Kemal Street, No:7, Sarigazi Emek, Istanbul, Turkey.  
E-mail: emine\_altuntas@hotmail.com P: +90 216 606 33 00 F: +90 216 606 33 97  
Corresponding Author ORCID ID: <https://orcid.org/0000-0001-5887-5422>

## Introduction

The new severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has been affecting the entire world since December 2019, causing the 2019 coronavirus (COVID-19) epidemic. The virus primarily affects the respiratory system. Although some coronavirus carriers are asymptomatic, others experience severe pneumonia and acute respiratory distress syndrome (ARDS). During the clinical course or even after recovery, the virus can affect other organs, especially the cardiovascular system [1].

COVID-19 infection can cause acute myocardial damage, heart failure, arrhythmia, acute coronary syndrome, and thromboembolism during and after the disease process. SARS-CoV-2 binds to the transmembrane angiotensin-converting enzyme 2 (ACE2) protein. This protein is found in high amounts in pericytes. Once the virus attaches to this protein, it can enter the cell and disrupt the microvascular circulation. Thus, cardiovascular complications can occur. In addition, the current inflammatory process is believed to cause platelet activation, endothelial dysfunction, and stasis [1,2].

Mortality and morbidity rates are high in COVID-19 patients with cardiovascular disease. In this study, we aimed to determine the demographic and clinical characteristics of patients infected with COVID-19 and acute coronary syndrome and to investigate whether they differ from patients with acute coronary syndrome (ACS) who were not infected with COVID-19 in terms of these characteristics.

## Material and Methods

### Patient selection

This single-center retrospective study included 33 patients with acute ACS and COVID-19 infection (Group 1) and 100 patients with ACS without COVID-19 infection (Group 2). The diagnosis of acute coronary syndrome was made according to the diagnostic criteria of the European Society of Cardiology (ESC) non-ST elevation myocardial infarction (NSTEMI) guideline published in 2020 [3] and the ST-elevation myocardial infarction (STEMI) guideline published in 2017 [4]. The diagnosis of COVID-19 was first made on the basis of clinical findings and computed thoracic tomography, and then confirmed by COVID-19 swab test using real-time reverse transcriptase--polymerase chain reaction (RT-PCR). Patients with clinical and tomographic findings compatible with COVID-19 were found to be positive for COVID and treated accordingly. Patients who were not pregnant and aged > 18 years were included in the study. The medical history of patients was obtained from hospital records. Patients with out-of-hospital cardiac arrest who did not achieve return of spontaneous circulation were excluded from the study. This study was conducted by the COVID-19 Scientific Research Evaluation Commission of the Ministry of Health of the Republic of Turkey, with approval of the study on 31/05/2020 and the approval of the Ethics Committee of Sancaktepe Sehit Prof. Dr. Ilhan Varank Education and Research Hospital, Clinical Research Ethics Committee No. 1 (date: 18/11/2020, No. 2020-43).

### Evaluation of blood sample tests

Total cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), triglyceride, fasting blood glucose and thyroid-stimulating hormone were studied from the blood

samples that were taken after at least 8 hours of fasting. Creatinine, albumin, C- reactive protein (CRP), procalcitonin, fibrinogen, D-dimer, high-sensitivity troponin I (hs troponin I), and complete blood count were studied from the blood tests taken immediately after admission to the hospital.

### Echocardiographic evaluation

Heart chamber diameters, valvular pathology, systolic pulmonary artery pressure, and ejection fraction (EF) (measured using the modified Simpson method) data were obtained from the apical and parasternal axes with a 2.5 MHz transducer and echocardiography machine (Vivid 5; GE Healthcare, Inc. Chicago, IL, USA).

### Coronary angiography

STEMI patients had immediate coronary angiography, while those with NSTEMI who did not have high-risk criteria underwent coronary angiography within the first 24-48 hours. All patients received a loading dose of acetylsalicylic acid 300 mg and clopidogrel 600 mg, or ticagrelor 180 mg before the procedure. During the procedure, all patients were loaded with iv heparin at a rate of 70-100 IU / kg.

A panel of 2 interventional cardiologists, blinded to patient COVID-19 status, retrospectively reviewed cine-angiographic images of all patients and scored pre- and post-percutaneous coronary intervention (PCI) TIMI flow in the infarct-related artery, thrombus burden pre- and post-PCI, and myocardial blush grade.

### Follow-up

Patients in-hospital mortality, their admission to the hospital with acute coronary syndrome, cerebrovascular event, heart failure at the end of the first month, and combined total death rates were obtained from the medical records.

### Statistical analysis

IBM SPSS Statistics for Windows, Version 18.0 (IBM Corp., Armonk, NY, USA) was used to perform the statistical analysis. Shapiro- Wilk test was used to assess the normality of distribution of the variables. Quantitative variables with normal distribution were specified as mean  $\pm$  standard deviation, and non-normally distributed variables were specified as median (interquartile range). Categorical variables were shown as numbers and percentages. The non-normally distributed variables were assessed with the Mann-Whitney U test, while normally distributed variables were assessed with an independent sample Student's t-test.

## Results

The average age in Group 1 was 65.9 years, and 59.75 years in Group 2, and there was no significant difference. In Group 1, 21 (63%) individuals were males. In Group 2, 74 (74%) of the patients were male, and the two groups were considered similar in this respect. In the COVID-19 patient group, 19 (57.57%) patients had positive nasal swabs, on the other hand, lung involvement on non-contrast thoracic tomography was typical for COVID 19 pneumonia in 14 (42.43%) patients. The groups were compared in terms of chronic disease history. Patients with a history of coronary intervention were more common in the COVID 19 patient group. Hypertension (HT) was more common in the control group. There was a significant difference between the groups in terms of these two diseases

(p = 0.001 and 0.024, respectively). Other demographic and clinical characteristics are summarized in Table 1. The patients were compared in terms of laboratory test results. Hemoglobin, lymphocyte count, albumin, total cholesterol and triglyceride levels were higher in Group 2 (p= 0.041; 0.001; 0.000; 0.018; 0.05, respectively). In Group 1, the levels of CRP, and D-dimer were high (p = 0.000; 0.006, respectively), which led to a significant statistical result. Other laboratory results are summarized in Table 1. Patients were also compared in terms of coronary angiographic characteristics. Twenty-eight (84.8%) patients in the COVID 19 group and 74 (74%) in the control group presented with NSTEMI. On the other hand, 5 patients (15.2%) in Group 1 (15.2%) and 26 patients (26%) in Group 2 presented with STEMI. There was no statistical difference between the groups in terms of these characteristics (p> 0.05). Other angiographic features are summarized in Tables 2, 3.

Table 1. Demographic, clinical characteristics and blood tests comparison of the groups

	COVID-MI (n=33)	Controls (n=100)	P
Age (year)	65.9 (49.5±80)	59.75 (48±65)	0.47
Sex	Male; 21 (63.6%)	Male; 74 (74%)	0.253
Smoking	11 (33.3%)	46 (46%)	0.229
COVID-19 test results			
CT(+)	14 (42.43%)	-	-
Swap (+)	19 (57.57%)	-	
Entubation	4 (12.1%)	5 (5%)	0.158
Lenght of stay in intensive care unit (Day)	4 (2,5±5)	2 (2±3)	0.000
Lenght of stay in hospital (Day)	6 (4.5±11)	4 (3±5)	0.001
Ischemic heart disease			
CABG	5 (15.2%)	6(6%)	0.098
PCI	17 (24.8%)	21 (21%)	0.001
Diabetes mellitus	16 (48.5%)	33 (33%)	0.11
Hypertension	22 (24.8%)	44 (44%)	0.024
Chronic kidney disease	0 (0%)	3 (3%)	0.574
Cerebrovascular Event	1 (3%)	1 (1%)	0.436
Hemoglobin (g/dL)	13.04 (12.2-14.16)*	13.65 (12.7-15.1)	0.041
Neutrophil (103/uL)	7.408 (5.500-9.035)	9.862 (5.670-8.960)	0.864
Lymphocyte (103/uL)	2.028 (900-2.420)	2.667 (1.860-3.310)	0.001
Procalcitonin (ng/mL)	0.21 (0.05-0.29)	0.17 (0.05-0.15)	0.526
C- reactive protein (mg/L)	3.54 (0.55-1.58)	3.48 (0.75-6.75)	0.000
Albumin (g/L)	35.04 (31.36-36.87)	42.51 (38.6-45.075)	0.000
High sensitive (hs) troponin I (pg/mL)	36.933 (219.5-11.648)	29.219 (690-44.822)	0.144
D-dimer (mg/L)	2.19 (1.03-3.2)	0.80 (0.3-1.43)	0.032
Fibrinogen (mg/dL)	533.81±208.74**	445.36±112.39	0.061
Total cholesterol (mg/dL)	158±47.8	180.56±40.76	0.018
LDL (mg/dL)	97.46±40.94	108.26±35.29	0.186
HDL (mg/dL)	37.28 (27.75-48.25)	38.88 (32-45)	0.309
Triglycerides (mg/dL)	170.96 (90-194.5))	182.73 (110-215)	0.05
Fasting blood glucose (mg/dL)	140.6 (95.5-172.5)	150.2 (97.25-192.5)	0.218
Creatinin (mg/dL)	0.85 (0.75-97.5)	0.9 (0.87-0.93)	0.479
Ejection Fraction (%)	49.18 (45±55)**	51.53 (45±60)	0.158

CABG: Coronary artery bypass graft; CT: Computed tomography; dL: deciliter; gr: Gram; HDL: High- density lipoprotein; L: Liter; LDH: Lactate dehydrogenase, LDL: Low-density lipoprotein; mg:Miligram; mIU: mili international unit; mL: milliliter; uL: microliter; ng: nanogram; U:Units; PCI: Percutaneous coronary intervention, \*Interquartile range, \*\*Standard deviation

Table 2. Coronary angiography results

Parameters	COVID-MI (n=33)	Controls (n=100)	p
Type of MI			
NSTEMI	28 (84.8%)	74 (74%)	0.201
STEMI	5 (15.2%)	26 (26%)	
>50% occlusion			
LMCA	3 (9.1%)	5 (5%)	0.391
LAD	20 (60.6%)	60 (60%)	0.951
CX	18 (54.5%)	46 (46%)	0.394
RCA	13 (39.4%)	47 (7%)	0.446
IM	1 (3.1%)	5 (5%)	1
Decision of Procedure			
Medical	10 (30.3%)	24 (24%)	0.094
CABG	6 (18.2%)	7 (7%)	
PCI	17 (51.5%)	69 (69%)	
Multivessel thrombosis	1 (3%)	0 (0%)	0.248

CABG: Coronary artery bypass grafting; CX: Circumflex artery; IM: Intermedial artery; MI: Myocardial infarctus; NSTEMI: non ST-elevation myocardial infarctus; LAD: Left anterior descending artery; LMCA: Left mean coronary artery; PCI: Percutaneous coronary intervention; RCA: Right coronary artery; STEMI: ST- elevation myocardial infarctus

Table 3. Procedural characteristics of both groups

Parameters	Group 1 (n=17)	Group 2 (n=68)	P
Culprit vessel			
LMCA	0 (0%)	0 (0%)	0.244
LAD	9 (52.9%)	27 (39.7%)	
CX	6 (0.35%)	16 (23.5%)	
RCA	1 (5.8%)	21 (30.8%)	
LAD-RCA	0 (0%)	2 (2.9%)	
LAD-CX	0 (0%)	2 (2.9%)	
RCA-CX	1 (5.9%)	1 (1.4%)	
Baseline TIMI			
0	9 (52.9%)	27 (39.7%)	0.772
1	0 (0%)	1 (1.5%)	
2	1 (5.9%)	6 (8.8%)	
3	7 (41.2%)	34 (50%)	
Baseline thrombus grade			
0	8 (47.1%)	24 (35.3%)	0.682
1	0 (0%)	9 (1.2%)	
2	1 (5.9%)	5 (7.4%)	
3	2 (11.8%)	8 (11.8%)	
4	2 (11.8%)	5 (7.4%)	
5	4 (23.5%)	17 (25%)	
Post-PCI TIMI			
0	1 (5.9%)	3 (4.4%)	1
1	0 (0%)	0 (0%)	
2	1 (5.9%)	4 (5.9%)	
3	15 (88.2%)	61 (89.7%)	
Myocardial Blush grade (end)			
0	1 (5.95)	5 (7.4%)	0.829
1	0 (0%)	0 (0%)	
2	0 (0%)	4 (5.9%)	
3	16 (94.1%)	59 (86.8%)	
Multivessel PCI	0 (0%)	5 (7.2%)	0.578
Thrombus aspirating catheter using	1 (5.9%)	2 (2.9%)	0.488
Stent Thrombosis	1 (5.9%)	2 (2.9%)	0.488

CABG: Coronary artery bypass grafting; CX: Circumflex artery; IM: Intermedial artery; MI: Myocardial infarctus; LAD: Left anterior descending artery; LMCA: Left mean coronary artery; PCI: Percutaneous coronary intervention; RCA: Right coronary artery; TIMI: Thrombolysis in Myocardial Infarction

## Discussion

This study summarizes data from patients with and without COVID-19 who were admitted to a primary percutaneous intervention center and underwent coronary imaging. The patients included in the study were not divided into NSTEMI and STEMI groups. Therefore, this study differs from other coronary imaging studies.

The main finding of our study is that in patients with COVID-19 and ACS the thrombus burden was not higher than in ACS patients without COVID-19 infection.

One of the important features of COVID-19 infection is the microcirculatory endothelial damage in pulmonary circulation and other vascular beds [5]. Since COVID-19 directly infects vascular endothelial cells, causing cellular damage and apoptosis, the antithrombotic activity of the luminal surface is remarkably decreased. Subsequently, damage of the endothelium leads to procoagulant changes in the vascular lumen, the formation of immunothrombosis, and organ maldistribution [6]. Choudry et al. studied 39 STEMI patients with COVID-19 and 76 STEMI control patients. In this study, there were no significant differences between the groups in terms of basal TIMI, basal thrombus stage, or target vessel post-PCI TIMI, but differences were observed in terms of myocardial blush (end) stage, modified thrombus stage using an aspiration catheter, stent thrombosis, and multiple vessel intervention. It was observed that stent thrombosis and thrombus aspiration catheter use were more common, and the modified thrombus and myocardial blush stages were higher in the COVID-19 group [7]. Unlike the study by Choudry et al., in two separate studies involving 28 and 18 STEMI patients, it was reported that lesions with high thrombus load were not more common in COVID patients [8,9]. In our study, there were no significant differences between the groups in terms of these parameters. Even after separating patients into STEMI and NSTEMI groups, there were no significant differences in our study. This may be due to the small study population. Similar to the study by Choudry et al., the duration of stay in the hospital and intensive care unit was longer in the COVID-19 group [7].

It has been determined that HT is more common in COVID-19 patients, and the disease is more severe in those with HT [10]. It has been suggested that HT causes the immune system to work irregularly. In our study, HT was more common in the control group, whereas past history of PCI was more common in the COVID-19 group.

COVID-19 infection is an inflammatory process that causes coagulation activation and endothelial dysfunction. It was observed that cardiac and coagulation biomarker levels were elevated during COVID-19 infection. Increased D-dimer and troponin levels have been associated with increased mortality and morbidity [11]. Although the groups in this study were found to be similar in terms of hs-troponin I, D-dimer levels were found to be higher in the COVID-19 patient group.

The bone marrow response to COVID-19 infection changes the course of the disease. Excessive immune reaction causes a cytokine storm, leading to increased risk of death [12]. CRP, procalcitonin, neutrophil, lymphocyte, albumin, and fibrinogen levels and the neutrophil/lymphocyte ratio can be used to predict this response and the course of the disease. In some studies, it

has been found that lymphocyte levels are low and neutrophil levels are high in patients with severe COVID-19 [13,14]. In addition, in severe cases, high levels of CRP, procalcitonin, and fibrinogen have been observed. On the other hand, albumin levels are low. In the study mentioned above, it was determined that hemoglobin, lymphocyte, and albumin levels were low in COVID-19 patients, whereas fibrinogen was higher and close to the statistically significant limits.

It has been previously shown that some viral infections affect cholesterol levels [15]. It has been shown in a study conducted on pig testicular cells and hamster renal cells that the depletion of cholesterol from the cell membrane of the SARS-CoV-2 virus causes a decrease in the severity of viral infection [16]. Wei et al. compared cholesterol levels of patients infected with COVID-19 with those of the normal population and showed that total cholesterol, HDL, and LDL were lower in the patient group [17]. This result has been supported by other studies (Hu X, Chen D, Wu L, He G, Ye W. Low Serum Cholesterol Level Among Patients with COVID-19 Infection in Wenzhou, China. Available at: <https://ssrn.com/abstract=3544826>) [18]. In our study, it has been proven that total cholesterol levels and triglyceride levels are lower in patients infected with COVID-19.

## Study limitations

The small number of patients in the study is the greatest limitation. The inclusion of patients with high hs-troponin I and patients with ST-elevation or depression is an additional limitation.

## Conclusion

In conclusion, although COVID-19 infection activates the coagulation and inflammation cascade and triggers thromboembolic events, we did not encounter increased thrombus burden among the groups in this study. This may be because the fact that the SARS-CoV-2 virus causes myocardial damage via plaque rupture, hypoxia, cytokine storm, coronary spasm.

## Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

## Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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## Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

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